For CADRE Use Only:	Paper #:	Paper ID:

PLEASE DOWNLOAD & SAVE THIS BLANK FORM BEFORE COMPLETING.

Abstract Submittal Form

JANNAF
PIB / 11th MSS / 9th LPS / 8th SPS
Joint Subcommittee Meeting
5 – 9 December 2016

Abstract Due Date: Monday, 11 July 2016 **Fields with an asterisk (*) are required.**

☐ **Check here if you are submitting an abstract because you have been INVITED to participate in a Specialist Session or Workshop. If so, who is the Chair?**

*** Title:** Predictive Evaluations of Oxygen-Rich Hydrocarbon Combustion Gas-Centered Swirl Coaxial Injectors using a Flamelet-Based 3-D CFD Simulation Approach.

* Submitted to: ☐ PIB ☐ MSS ☒ LPS ☐ SPS ☐ Other Please select ONE subcommittee.

Refer to Call for Papers for description of Subcommittee Mission Areas and select **one** from the choices below.

* Mission Area : ☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5

* *Updated Paper?* ☐ *Yes* ☒ *No*	* *Student Paper?* ☐ *Yes* ☒ *No*

Sponsoring organization if SBIR-funded:

IF MORE THAN 4 AUTHORS, PLACE THEIR COMPLETE CONTACT INFORMATION (as requested below) ON P.2 AFTER ABSTRACT TEXT.

Primary Author (NOTE: will receive all correspondence regarding participation in this program and is assumed to be presenter)

* Name: Brian R. Richardson		* U.S. Citizen ☒ *Yes* ☐ *No*
* Organization (contractors provide company name): Jacobs ESSSA Group		
* Address: NASA Marshall Space Flight Center, Bldg 4203 Rm 3428		
* City: Huntsville	* State: AL	* ZIP Code: 35812
* Phone: 256-544-9396	Fax:	* Email: brian.r.richardson@nasa.gov

2nd Author **Please provide full contact information for each author.**

Name: Kalem Braman		* U.S. Citizen ☒ *Yes* ☐ *No*
Organization (contractors provide company name): Jacobs ESSSA Group		
Address: NASA Marshall Space Flight Center, Bldg 4203 Rm 3427		
City: Huntsville	State: AL	ZIP Code: 35812
Phone: 256-544-8537	Fax:	Email: kalen.e.braman@nasa.gov

3rd Author **Please provide full contact information for each author.**

Name: Jeff West		* U.S. Citizen ☒ *Yes* ☐ *No*
Organization (contractors provide company name): NASA/MSFC		
Address: NASA Marshall Space Flight Center, Bldg 4203 Rm 3102		
City: Huntsville	State: AL	ZIP Code: 35812
Phone: 256-544-6309	Fax:	Email: jeffrey.s.west@nasa.gov

4th Author **Please provide full contact information for each author.**

Name:		* U.S. Citizen ☐ *Yes* ☐ *No*
Organization (contractors provide company name):		
Address:		
City:	State:	ZIP Code:
Phone:	Fax:	Email:

☐ Check this box if you are listing additional authors on page 2 after the abstract.

*** Management Support**	*** U.S. Citizenship**

☒ Author(s) has confirmed management support (i.e., required resources) is available to prepare, submit, and present this paper at the above subject JANNAF Meeting.	The presenting author for this paper will be BRIAN R. RICHARDSON. **ERG must be notified of any change to the presenting author immediately.** Presenter must be a U.S. Citizen; attendance at this meeting is restricted to U.S. Citizens.

For CADRE Use Only: Paper #: Paper ID:

Abstract Submittal Form

JANNAF
PIB / 11th MSS / 9th LPS / 8th SPS
Joint Subcommittee Meeting
5 – 9 December 2016

Abstract Due Date: Monday, 11 July 2016

Fields with an asterisk (*) are required.

Unclassified Abstract (250 – 300 words; do not include figures or tables)

* NASA Marshall Space Flight Center (MSFC) has embarked upon a joint project with the Air Force to improve the state-of-the-art of space application combustion device design and operational understanding. One goal of the project is to design, build and hot-fire test a 40,000 pound-thrust Oxygen/Rocket Propellant-2 (RP-2) Oxygen-Rich staged engine at MSFC. The overall project goals afford the opportunity to test multiple different injector designs and experimentally evaluate the any effect on the engine performance and combustion dynamics. To maximize the available test resources and benefits, pre-test, combusting flow, Computational Fluid Dynamics (CFD) analysis was performed on the individual injectors to guide the design. The results of the CFD analysis were used to design the injectors for specific, targeted fluid dynamic features and the analysis results also provided some predictive input for acoustic and thermal analysis of the main Thrust Chamber Assembly (TCA).

MSFC has developed and demonstrated the ability to utilize a computationally efficient, flamelet-based combustion model to guide the pre-test design of single-element Gas Centered Swirl Coaxial (GCSC) injectors. Previous, Oxygen/RP-2 simulation models utilizing the Loci-STREAM flow solver, were validated using single injector test data from the EC-1 Air Force test facility. The simulation effort herein is an extension of the validated, CFD driven, single-injector design approach applied to single injectors which will be part of a larger engine array.

Time-accurate, Three-Dimensional, CFD simulations were performed for five different classes of injector geometries. Simulations were performed to guide the design of the injector to achieve a variety of intended performance goals. For example, two GCSC injectors were designed to achieve stable hydrodynamic behavior of the propellant circuits while providing the largest thermal margin possible within the design envelope. While another injector was designed to purposefully create a hydrodynamic instability in the fuel supply circuit as predicted by the CFD analysis. Future multi-injector analysis and testing will indicate what if any changes occur in the predicted behavior for the single-element injector when the same injector geometry is placed in a multi-element array.

Audio-Visual Requirements and Room Setup

Standard equipment supplied in each meeting room includes: Laptop (with sound), LCD Projector (minimum 1024 x 768 native resolution and 4500 lumens), Screen, Podium Microphone, Wireless Lavalier Microphone. Rooms are typically set in "Theater" style (rows of chairs). **If your presentation requires any unusual A-V equipment or set-up, please indicate those requirements below.**

Enter any unusual A-V or room setup requirements here. First check the list of standard equipment and typical room setup described above.This section will EXPAND to accommodate your text.

- **If your abstract is anything other than Distribution Statement A, you must upload both pages of this completed form to the CPIAC secure website.** Upload instructions can be found in the Call for Papers on page 3.
- Distribution Statement A abstracts may be uploaded or emailed.
- By submitting an abstract, you agree to both complete a final paper for publication and to attend the meeting to present this information.
- Direct questions to Shelley Cohen, by phone at 410.992.7302 x 215, or email to scohen@erg.jhu.edu.

Form Date: 5/25/16